Surgical Anatomy of the Spinal Accessory Nerve and the Trapezius Branches of the Cervical Plexus

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Background: A thorough understanding of the topographical anatomy of the spinal accessory nerve and the cervical plexus branches is a basic prerequisite for positive results when operating on the neck.

Objective: To give an exact description of the topographical and surgical anatomy of the spinal accessory nerve (SAN) and the trapezius branches of the cervical plexus.

Design: Anatomic analysis of the SAN and the trapezius branches of the cervical plexus.

Setting: The topographical anatomy of the SAN and the cervical plexus branches were studied in the anterior and posterior triangles of the necks of 46 perfusion-fixed human cadavers of both sexes, which ranged in age from 55 to 97 years (mean age, 83 years).

Results: The SAN can be identified on the posterior border of the sternocleidomastoid (SCM) muscle, 8.2±1.01 cm cranial to the clavicle. In 37% of cases, the SAN enters the posterior triangle of the neck dorsal to the SCM muscle, where it passes through the muscle in 63% of these cases. In the anterior triangle of the neck, the SAN crosses the internal jugular vein ventrally in 56% of the cases and dorsally in 44%. Regarding the cervical plexus, 1 trapezius branch could be found in 9% of the specimens, 2 in 61%, and 3 in 30%. None of the branches merged with the SAN medial to the anterior border of the trapezius muscle. In most cases, a tiny additional branch could be found arising from the SAN about 2 cm medial to the trapezius muscle. This branch enters the descendant part of the muscle approximately 2 to 3 cm cranial to the main nerve.

Conclusions: Surprisingly, available data on topographical as well as surgical anatomy of the SAN and the trapezius branches of the cervical plexus are confusing and often wrong. The descriptions given herein can help to minimize the risk of injuring the SAN during neck surgery and preserve the additional innervation of the trapezius muscle granted by the rami trapezi of the cervical plexus.

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Ever since radical neck dissection was first described by George Crile in 1906, it has played an important role in tumor surgery of the head and neck. Loss of function in the shoulder girdle is one of the most disabling postoperative consequences for patients. Within the last 2 decades, many surgeons have tried to avoid radical neck dissections to save the spinal accessory nerve (SAN) and thereby the integrity of the trapezius muscle innervation and have performed modified neck dissections whenever oncologically justified. Nonetheless, strong evidence exists that the SAN is involuntarily injured during surgery in up to 71% of cases, which is obviously much more than one would expect. During the last 93 years, discussion has focused on the question of when a modified neck dissection is oncologically justified rather than on the surgical anatomy of the structures that should be saved. Until now, very little has been written on how to identify the SAN easily and without harming it. However, the few works dealing with this special question are confusing and even contradictory.

Furthermore, there is still considerable disagreement between anatomists and surgeons regarding the trapezius muscle motor innervation. Most anatomists consider the SAN to be the only motor nerve supply to the trapezius muscle, whereas from the physicians’ point of view, both the SAN and the cervical plexus branches are mixed nerves, contributing more or less equally to the motor innervation of the muscle. Nonetheless, it is generally agreed that the SAN should be saved whenever possible to achieve a positive result.

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However, this can be achieved only on the basis of a thorough understanding of topographical anatomy.8

The aim of this study is to clarify the topographical anatomy of the SAN and the rami trapezii of the cervical plexus as related to surgery of the neck. In addition, we want to establish a reliable landmark for the identification of the SAN to minimize the considerably high rate of unexpected trapezius muscle paresis after modified neck dissection.

RESULTS

The distance between the clavicle and the point where the SAN enters the posterior triangle of the neck on the laterodorsal side of the sternocleidomastoid (SCM) muscle was measured (Figure 1) in 46 individuals. In 2 posterior triangles of the neck, the SAN was cut because of former preparation by students; therefore, 90 triangles remained. On average, the SAN was identified at 8.2±1.01 cm cranial to the clavicle (Figure 2). In 11 individuals (24%), the distance was the same on both sides.

The relationship between the SAN and the SCM muscle was investigated in 46 cadavers, ie, 92 posterior triangles of the neck. The SAN entered the posterior triangle behind the posterior border of the SCM muscle in 58 (63%) of 92 triangles, whereas it left the muscle surrounded by muscle fibres in 34 posterior triangles of the neck (37%). In 6 cadavers (13%), there was a difference between the right and the left side. In 7 (29%) of 24 triangles of the neck, the SAN did not pass through the SCM muscle at all. The topographical relationship between the SAN and the internal jugular vein (IJV) was investigated in 24 cadavers. In 5 of the 48 anterior triangles, the relationship between these 2 structures could not be clarified, because the IJV had been cut lower in the neck. The SAN crossed the IJV ventrally in 24 preparations (56%), and dorsally in 19 (44%). A difference between the right and the left side occurred in 4 cadavers (17%).

The number and topography of the trapezius branches of the cervical plexus were investigated in 22 cadavers (44 posterior triangles of the neck). In 4 posterior triangles (9% of the 44), only 1 trapezius branch was present. Two trapezius branches were present in 27 triangles, (61%). In 6 preparations, (22%), these 2 branches were present in 34 triangles (41%).

MATERIALS AND METHODS

Ninety-two anterior and posterior triangles of the neck were taken from 46 human cadavers of both sexes (20 male and 26 female) ranging in age from 55 to 97 years (mean age, 83 years). The cadavers were donated to the Institute of Anatomy, University of Vienna, Vienna, Austria, and were prepared for anatomical dissection courses (4% phenolic acid and 0.5% formaldehyde).

Only specimens without signs of previous surgery or any other severe abnormality in the regions of interest were accepted. The anterior and posterior triangles of the neck were dissected by one of us (A.C.K. or I.Z.), who documented the findings immediately. Results were reviewed by the other author (I.Z. or A.C.K.) independently. In addition, sketches were drawn of all preparations, and photographs were taken of all representative as well as exceptional cases.

Figure 1. Left side of the neck. Typical anatomical situs in the posterior triangle of the neck. Notice the fine cranial branch (small thick arrow) of the spinal accessory nerve (large thick arrow) passing into the descending part of the trapezius muscle, the 2 trapezius branches of the cervical plexus (thin arrows), and their characteristic relationship toward the transverse cervical artery (star). The asterisk indicates the minor occipital nerve. The white line marks the distance measured on the posterior border of the sternocleidomastoid muscle (SCM) between the clavicle (C) and the spinal accessory nerve (large thick arrow).

Figure 2. Diagram of the statistical incidence of the distances measured between the clavicle and the point where the spinal accessory nerve enters the posterior triangle of the neck at the posterior border of the sternocleidomastoid muscle.
branches arose from a common trunk a short distance lateral to the posterior border of the SCM muscle (Figure 3). In 13 triangles (30%), 3 trapezius branches were found. In 8 (62%) of the 13 preparations, 2 of the 3 branches arose from a common trunk lateral to the posterior border of the SCM muscle. In 36 posterior triangles of the neck, of the 40 with at least 2 trapezius branches, 2 different types of branches could be distinguished. One branch was passing through the triangle superficially, immediately caudal to the SAN. The other branch was almost always thicker than the first one, running deeper and further caudal toward the trapezius muscle (Figures 1 and 3). None of the branches merged with the SAN medial to the anterior border of the trapezius muscle.

In most cases, a very small additional branch could be found arising from the SAN about 2 cm medial to the trapezius muscle. This branch enters the descendant part of the muscle approximately 2 to 3 cm cranial to the main nerve (Figure 2 and Figure 3).

In 6 preparations, the minor occipital nerve passed into the posterior triangle of the neck at the posterior border of the SCM muscle about 1 to 2 cm caudally to the SAN, running parallel to it toward the anterior border of the trapezius muscle. In these cases, the minor occipital nerve turned upward, crossing the SAN as far lateral as the anterior border of the trapezius muscle, forming a kind of nerve plexus (Figure 2 and Figure 3).

**COMMENT**

The rate of iatrogenic lesions of the SAN during neck surgery is considerably high, and most surgeons seem to be aware of this fact. Nonetheless, anatomic descriptions of the exact course of the SAN and adjacent structures given in the literature are surprisingly confusing and often wrong. In the present study, we tried to elucidate the surgical anatomy of all nerves involved in trapezius muscle innervation. It can be clearly shown that the SAN crosses the IJV ventrally in 56% of the patients and dorsally in 44%. The course of the SAN occurred independently on each side. In almost one third of the preparations—much more often than one would expect—the SAN did not pass through the SCM muscle but lay dorsal to it.98 If it passes through the muscle, however, one must be aware that the SAN takes a 3-dimensional course instead of running straight through. Independently of this topographic feature, the nerve enters the posterior triangle of the neck at the lateral border of the SCM muscle, on average 8.2 cm cranial to the clavicle (Figure 1). In addition, 1 to 3 (in most cases 2) branches of the cervical plexus run to the trapezius muscle and contribute to its innervation. These branches pass through the posterior triangle of the neck independently of the SAN, very rarely intermingling with it. In most cases, there was a thin cranial branch and a thicker one lying deeper and more caudally. In the posterior triangle of the neck, the SAN may intermingle with the cervical plexus branches, but this is the exception rather than the rule.17,23

Because considerable confusion exists in the literature, we think that one cannot put too much emphasis on the following anatomical principles:

1. The SAN can be found medial as well as lateral to the IJV, depending on how far cranial in the neck it is identified. The crossing between these 2 important structures can happen only dorsally (44%) or ventrally (56%) to the IJV. In this respect, we disagree with the findings of Krause et al19 and Soo et al.10

2. When the SAN passes through the SCM muscle, it takes an S-shaped, 3-dimensional course instead of running straight through the muscle as Becker and Parell9 state. If the nerve were followed through the muscle the way the previously mentioned authors suggest, the communicating branch(es) with the cervical plexus would obviously be cut.

3. The cervical plexus branches passing to the trapezius muscle are always subfascial because another relationship to the fasciae of the neck—whether superficial or deep—is anatomically impossible.19,20,24

4. The SAN can easily be mixed up with the minor occipital nerve because the latter sometimes takes a similar course, turning upward just slightly medial to the anterior border of the trapezius muscle (Figure 2 and Figure 3). Therefore, the supposed SAN must be followed right to the anterior border of the trapezius muscle to be sure that it keeps its cranio-caudal direction. Furthermore, we found that measuring at the posterior border of the SCM muscle from the clavicle provides the most reliable results and that the nerve can always be identified. The other landmarks cited in the literature, such as the great auricular nerve or the SCM muscle itself, show much more variability.9,9,21

In a few preparations, cutaneous branches of the posterior spinal nerves passed through the tendon plane between the spinous processes of the vertebral column and the trapezius muscle to reach the skin. However, in contradiction to some former works, they were never found to branch within the muscle, which would have indicated additional innervation.38

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**Figure 3.** Right side of the neck. Typical anatomical situs in the posterior triangle of the neck. Notice the 2 trapezius branches of the cervical plexus (thin arrow) originating from 1 common trunk.
Although Karuman and Soo have recently made a leap toward discovering the entire system of trapezius muscle innervation, we do not yet believe that this old question has been answered sufficiently. It still remains to be determined if (1) the segmental branches really do not branch inside the trapezius muscle, thus indicating an additional motor innervation, and if (2) some additional deep branches that cannot be detected by macroscopic dissection grant nervous supply to the muscle. Furthermore, another detailed investigation will be necessary regarding the existence and role of the small cranial SAN branch entering the descendant part of the trapezius muscle. As far as we know, this branch has been described for the first time, a fact that might also contribute to the number of unexpected trapezius muscle pareses.

The data presented herein can help to minimize the risk of injuring the SAN during neck surgery and preserve the additional innervation of the trapezius muscle granted by the rami trapezii of the cervical plexus.

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